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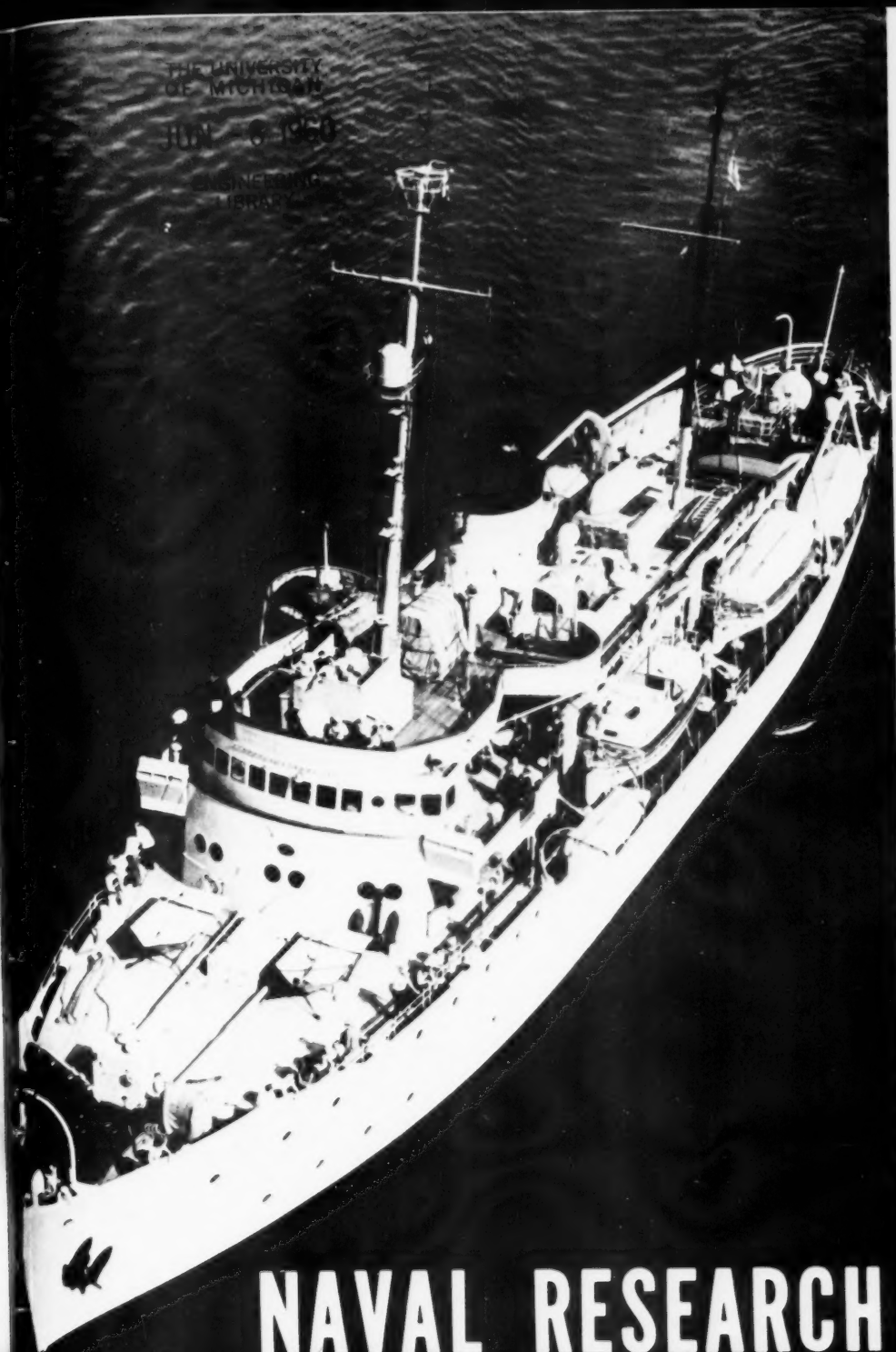

NAVAL RESEARCH

REVIEWS

MAY 1960

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH

Mockup of an integrated control center for nuclear submarines of the near future. These simplified controls utilize electronic computers, data-processing equipment, and visual displays. They are the results of SUBIC (integrated control applied to submarines), which combines the control of five fundamental submarine systems – weapons, communications, engineering, ship, and environmental. Note the absence of cable network. Coordinator of SUBIC's Navy-industry contractors, is General Dynamics Electric Boat Division, Groton, Conn. (General Dynamics photo.)

Direct Energy Conversion*

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Research on direct energy conversion is directed primarily toward the utilization of nuclear energy. The same conversion processes, however, work equally well with other sources of energy, and for any particular application, all possible combinations of energy source and conversion processes need to be examined. We are concerned therefore, with utilizing all three fundamental sources of energy: solar energy, both in the form of radiation and absorbed as heat; chemical energy, primarily as the combustion of fossil fuel, but also as electrochemical reactions; and nuclear energy producing heat from the decay of isotopes and from fission processes in reactors.

The four energy conversion processes receiving the majority of attention are photovoltaic cells, thermoelectricity, thermionic emission, and fuel cells. Other possibilities exist such as magnetohydrodynamics which, to become feasible, must wait for the solution of extremely difficult problems related to high-temperature materials. Pyroelectricity, Curie-point inversions, and several others might be considered, but they all appear to have serious limitations except for special applications. Those processes which look immediately promising are the first four.

The most highly developed today are the solar cells utilizing energy in the form of radiation. In the most familiar form, a very perfect silicon crystal is treated with traces of impurities that introduce extra positive and negative charges on the two sides of a thin wafer (Figure 1). These extra charges remain on their own side of the junction that separates the two sides until light energy strikes the crystal. This radiant energy further disturbs the electrical balance of charges and starts them moving toward the surfaces and the junction. This current flow then continues as long as light strikes the crystal.

The physics of this process is reasonably well understood, and the theory tells us that as much as 25 percent of the incident radiation can be converted to electricity – under special conditions possibly as high as 40 percent. The best now reported from the laboratory is 14 percent, and substantial production quantities can be obtained that give a 10 percent conversion efficiency. The cells are reliable and operate indefinitely with no loss in efficiency.

These represent the best available means of providing small amounts of power for satellite communications. The cells last so long, actually, that a time switch must be incorporated to shut off transmission after the desired interval. They are limited to small power supplies, however, because of their weight. Bare cells produce

*Presented to the Congress of the United States Joint Committee on Atomic Energy, Subcommittee on Research and Development, Hearings on Frontiers in Atomic Energy Research, March 22-25, 1960.

engineering, ship, and environmental. Note the absence of cable network. Courtesy of SUBIC's Navy-industry contractors, is General Dynamics Electric Boat Division, Groton, Conn. (General Dynamics photo.)

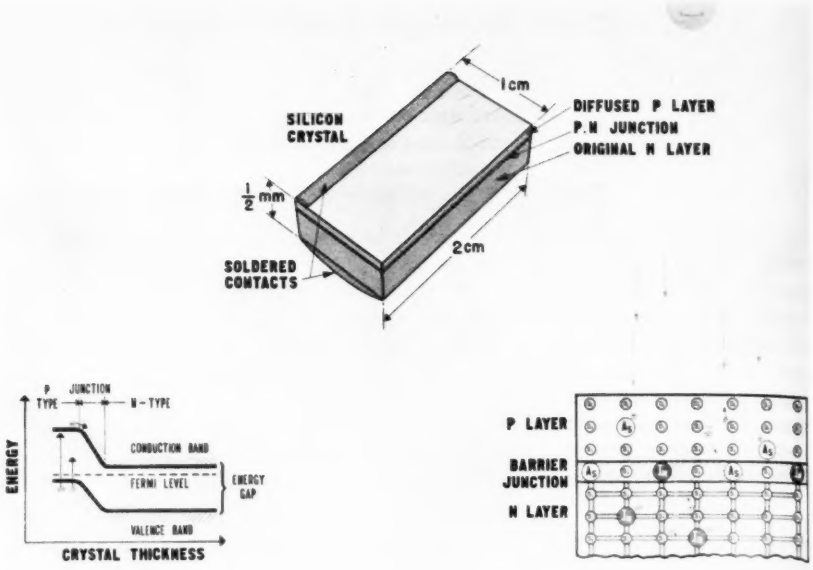

Figure 1-- Solar cell.

only 3 watts per pound. In a satellite, they must be distributed over the surface of a free tumbling sphere or a mechanism must be provided to keep them pointed at the sun. A third possibility is to use the solar cells to charge batteries which in turn provide current during dark periods. But all of these schemes add weight so that the complete power package delivers less than one watt per pound. Stated another way, the power supply weighs more than 1000 pounds per kilowatt—far too heavy to boost into space.

As large power supplies for ground stations, solar cells have a problem because of the size and cost. A 10-kilowatt generator suitable for a modern, home power supply, for example, would occupy 100 square yards and cost $2,000,000.

Most of the research effort is directed toward improved efficiency by growing more perfect crystals and by experimenting with different materials such as gallium arsenide and cadmium sulfide. Some increased efficiency can be expected but probably by no more than a factor of two. For space applications it would appear more profitable to attack the weight problem directly because the active region of the crystal is only a few millionths of an inch thick, a tiny fraction of the total thickness of the present wafers. There appears to be much room for improvement by using crystals in the form of thin films, and substantial improvements must be made for solar cells to remain competitive as other devices are developed. The best projection using existing solar cell techniques predicts 120 pounds per kilowatt, which is still much too heavy.

Another method for the utilization of solar energy is by collecting it and absorbing the heat content. For example, a mirror could be employed to collect and focus the sun's energy into a metal cylinder, where the concentrated heat could be used to operate thermocouples or thermionic diodes (Figure 2). In this instance heat would flow from the hot interior of the cylinder through the energy conversion device creating electricity, and the waste heat would be radiated into space, or in case of a ground installation waste heat would be discharged into a body of water.

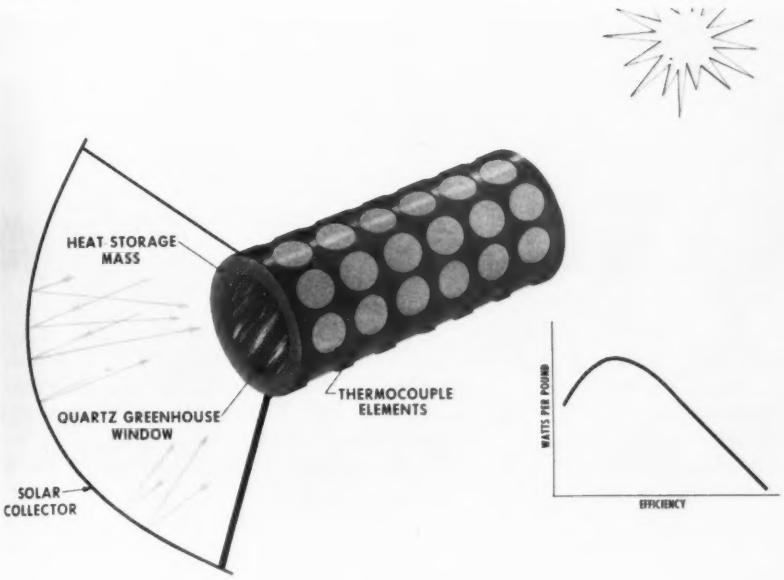

Figure 2--Solar thermal power supply.

The heat-conversion process which is receiving most attention at the present time is thermoelectricity. This is basically a very simple phenomenon (Figure 3). If a temperature difference is maintained across any bar of a material which conducts electricity, the electrons at the hot end of the bar move about more vigorously and tend to drift toward the cold end. It is entirely proper to say that heat pushes electricity through the bar. In some materials it is negative charges that move and in other materials the positive charges move. These opposite effects can be added together when the two types of materials are properly selected and are then joined to form a thermocouple.

This is a very old process. It was discovered in 1822 and efficiencies as high as 3 percent could be obtained in 1850. This was a higher efficiency than was obtained by the steam engines of that day. The scientists involved took a wrong turn, however, and no further progress was made – except that thermocouples have been widely used to measure temperature. Research in physics has recently taught us that to produce substantial amounts of power by the thermoelectric process, metals are the wrong materials. Metals have so many free electrons that increasing the temperature simply causes them to become

more crowded with little chance to drift. It is now recognized that semiconductors such as lead telluride—which have much smaller numbers of free electrons but with more freedom to drift—can produce substantially larger voltages and currents.

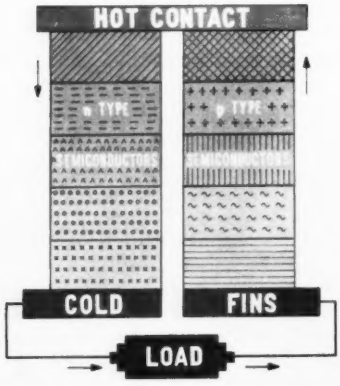

Figure 3--Thermoelectric effect

The physics of thermoelectricity is now reasonably well understood, and the theory indicates that efficiencies as high as 35 to 40 percent might be achieved. To accomplish this, the materials must have precisely the optimum set of properties in the face of a number of conflicting requirements. As previously stated, the number of free electrons must be small in order to generate a large voltage, yet large enough to avoid losses from internal resistance, which generates heat that flows in the wrong direction. And finally, the material must have a low thermal conductivity so that heat cannot flow through the material without doing some electrical work.

To complicate the situation further, each of these important properties of the material changes with temperature so that for any given material the best compromise of properties will exist for only a small temperature range. A thermocouple actually is a simple heat pump, and like all other heat engines, the efficiency increases with larger temperature differences. To operate over a wide temperature range requires, however, a number of materials each efficient in its small temperature region. The several materials, when put in series as shown in (Figure 3), perform much like the stages of a turbine. This requirement for using several different materials in the same thermocouple, including some that operate at high temperatures, makes the development difficult and expensive. Progress nevertheless is excellent. The program is now barely started, yet a conversion efficiency of 10 percent can be readily obtained. When a fuel burner is used as the source of heat, however, half of the total heat goes up the chimney so that the over-all efficiency of the system is reduced to 5 percent. The present weight is about 65 pounds per kilowatt, although a recent design for a space power supply indicates that a ratio as low as 5 pounds per kilowatt may be realizable.

Using thermocouples with nuclear heat is a promising possibility. By surrounding an isotope capsule with thermocouples, all the heat,

generated could be captured to yield an electrical output of 10 percent or more with today's materials. The present design concept involves using thermocouples with reactors, in which the primary coolant is circulated through a heat exchanger containing the thermoelectric materials; this is shown in Figure 4. No experience is available on which to base a predicted efficiency, but it is reasonable to expect that the heat losses would be substantially smaller and the efficiency therefore higher than with a fuel-fired thermoelectric system.

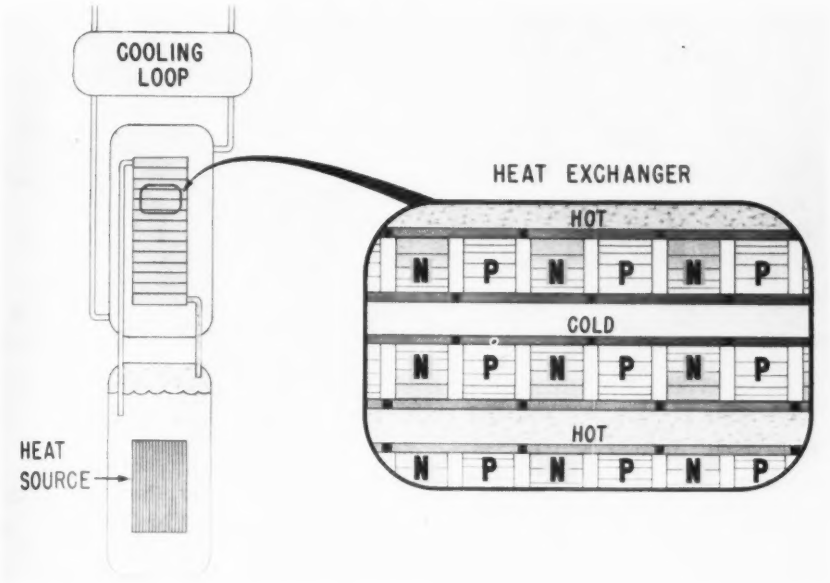

Figure 4--Thermoelectric power source.

The thermocouples would be placed in the cooling loop in present designs to protect the materials from radiation damage. It is intended ultimately to use the thermoelectric elements in the pile as sandwiches immediately adjacent to the fuel as shown in Figure 5. There are, in fact, possible fuel materials such as uranium and thorium sulfides which are themselves semiconductors and therefore potential thermoelectric elements. There must be a great deal more study of radiation damage, however, before such a system can be seriously proposed. Although very early results are encouraging, they are by no means sufficient to indicate any kind of conclusion.

The process which does lend itself readily to incorporation in the pile is thermionic emission. This too is basically a simple process, based on a discovery made by Thomas Edison. At one period early in his manufacturing of light bulbs, he had two independent filaments in the bulb, only one of which was connected at a time. After the first filament burned out, the bulb was turned around in the socket so that the spare filament was connected. In testing these bulbs, Edison discovered that he could draw a small current from the filament that was not connected. Some electricity was moving through the vacuum in the

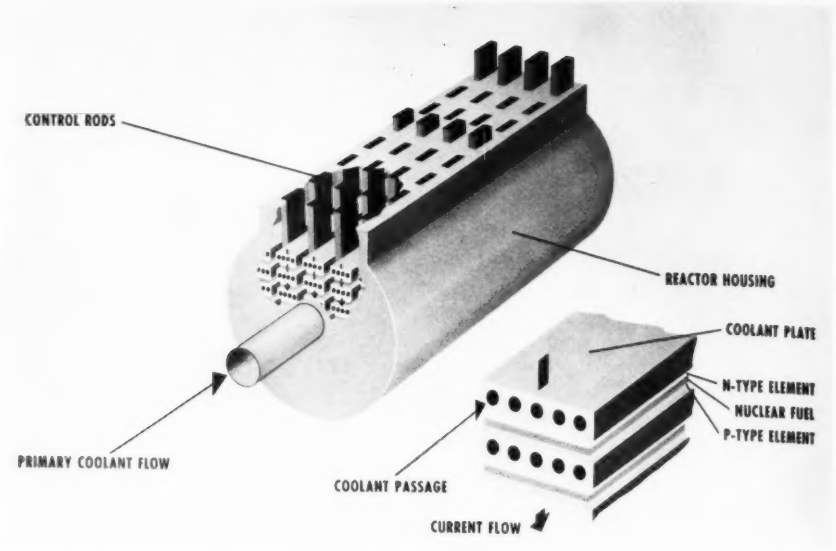

Figure 5--In-pile thermoelectric generator.

bulb from the hot filament to the cold. This is the basis on which all radio tubes operate, and the same process now promises to become an efficient energy converter.

To generate substantial amounts of power by the thermionic process, it is necessary for large numbers of electrons to flow from the hot cathode to the cold anode. Because the electrons are all negatively charged, they repel each other and build up a charge that limits further flow. This problem can be minimized by putting the cathode and anode very close together. The spacing required, however, is less than a ten thousandth of an inch which is virtually impossible to keep uniform between two surfaces over a large area, particularly at high temperatures.

Another way to minimize the space charge is by introducing an ionized gas between the electrodes. Positive charges on the gas plasma neutralize the negative electron charges and permit the current to flow. Calculations indicate that the process could have a theoretical efficiency of 40 percent or higher. Efficiencies of up to 13 percent have been demonstrated for brief periods in the laboratory, but enormous difficulties appear in producing a useful, long-lived device. The best that is available today is a small close-spaced diode with an efficiency of 2 percent.

The biggest problem is that the cathode must operate at such high temperatures that the material deteriorates rapidly. Also, the plasma doesn't behave quite like expected, and neither of the problems is likely to be easy to solve. The advantages, however, are also considerable. The diode is potentially the lightest weight of all energy converters. Design projections indicate less than one pound per kilowatt which would make them the obvious choice for space vehicles. The

biggest advantage, however, is the simplicity of the in-pile converter. The fuel rod itself acts as the cathode and the can acts as the anode (Figure 6) and very little else is involved. When efficiency and long-lived reliability are achieved, this is certainly the most simple of the nuclear energy converters.

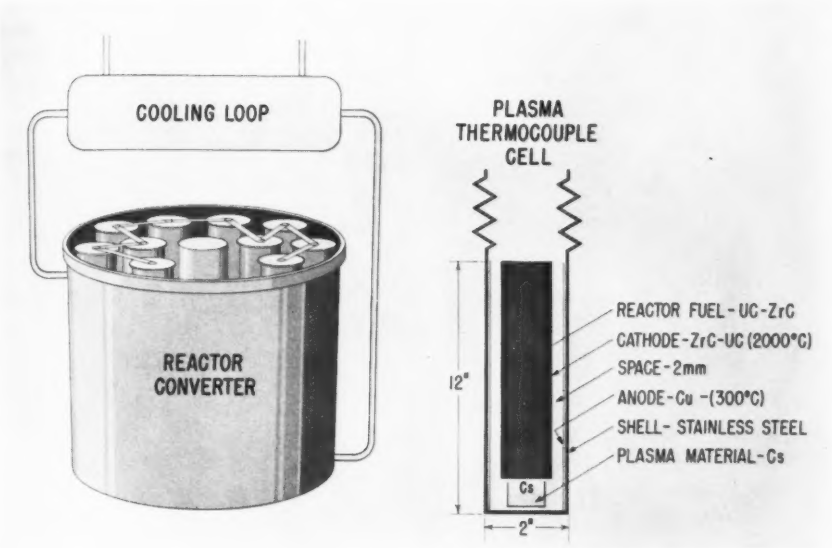

Figure 6--Nuclear thermionic converter.

For high efficiency, however, the continuous-feed fuel cell is the most promising device. Unlike the thermocouple and the diode, the simple fuel cell is not a heat engine. It is a battery and is limited only by chemical-reaction principles: two chemicals are fed into a cell where they react and produce an electric charge and a chemical byproduct. Theoretically, the efficiency can approach 100 percent, and as high as 90 percent has been demonstrated under special laboratory conditions. In the most simple form (Figure 7) hydrogen and oxygen gas are continuously fed through porous carbon rods which react in an electrolyte to form electricity and water. Such cells have operated continuously for 5 years at low output levels but develop problems as output levels are increased. The space required to store hydrogen limits the value of these cells for ships and space vehicles, but many other applications look promising.

Dozens of variations of fuel cells exist, utilizing a variety of chemicals. The most exciting possibility is a fuel cell which would use conventional petroleum products and air as the fuels; several companies have such cells in early stages of development. The general scheme is to use catalysts in the electrodes which would separate hydrogen from the hydrocarbons and use oxygen from the air as the other fuel. Such cells have been demonstrated with efficiencies exceeding 35 percent at low temperature and up to 75 percent at higher temperatures. The problem is to keep them operating at high output levels for long periods without having impurities poison the catalysts, thus reducing the efficiency.

Success in these devices could obviously have a large impact on the whole problem of power supplies. An efficiency of 60 to 80 percent is a very reasonable goal; as this is double the best efficiency of steam and internal-combustion engines, it would double the life expectancy of our fossil-fuel reserves.

To put into perspective the probable role of direct conversion processes in future power usage, it is helpful to consider the following characteristics which are common to all of these processes.

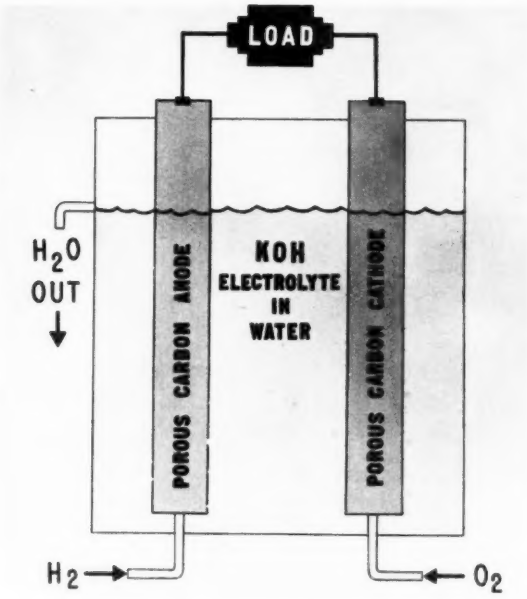

Figure 7--Hydrox fuel cell.

- All produce direct current—This characteristic carries well known advantages and disadvantages. The principal disadvantage is distribution losses, and this may be less important than might be supposed because of the final characteristic to be discussed below.

- Regulation and part-load efficiency present problems—Little effort has been devoted to this questioning, but maintaining efficiency as the load varies appears to be difficult.

- Design versatility is good—There appears to be unusually good flexibility of design so as to choose between minimum weight or minimum size or maximum efficiency.

- All are static systems—The absence of moving parts is responsible for two very important advantages.

- Efficiency is independent of size—This is likely to be the most significant of the direct conversion characteristics.

With nuclear turbines or combustion engines, efficiency is inevitably related to size. Efficiencies drop off from the neighborhood of 40 percent for very large central power stations to less than 5 percent for power plants of a few hundred watts. A small, efficient turbine plant using nuclear heat can not be built. Conversely, a large direct conversion plant for central distribution would have no advantage over a small direct conversion plant located where the power is to be used. Central distribution offers no advantages, so distribution losses of the d-c power is not a serious problem.

The total impact of direct conversion remains to be determined by future developments. It is not expected that any one direct conversion process will be a panacea for all power problems. Each will find applications based on its peculiar virtues. The first uses will be in applications where silence is more important than efficiency and in remote locations where freedom from maintenance is the determining factor. These applications will be followed by small power sources for various purposes, increasing in size and scope of applications as efficiency increases. To say how far this might go would be indulging in predictions from a clouded crystal ball. What seems certain is that direct conversion processes will solve important military problems, and it seems reasonable to expect that the progress made in connection with these developments and applications will lead to increasing civilian uses.

Dr. Haurowitz Receives the Paul Ehrlich Award

Dr. Felix Haurowitz, Distinguished Service Professor of Chemistry at Indiana University and an Office of Naval Research contractor, recently received the Paul Ehrlich Award at Frankfort, Germany. The award, named for the famed German immunologist and chemothereapist, is one of the highest honors in science. The last four winners of the award have been Nobel Prize winners. The ONR contractor expected to receive only the honor and a gold medal. Instead, he received a surprise of $12,500, his part of the $25,000 that goes with the award under a new provision by the German government. The remaining $12,500 will be designated by the winner for research of his choice. The award is in recognition of Dr. Haurowitz' work in the field of immunology—explaining how immunity to disease is acquired. Dr. Haurowitz is noted as an interpreter of biochemical progress. He is the author of the recent book, Progress in Biochemistry Since 1949, and four similar volumes published earlier. A member of the I. U. faculty since 1948, he attained his distinguished service professorship in 1958.

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Foaming the Runways

Every once in many, many thousand landing approaches, a plane's landing wheels refuse to come down. Standard procedure in this accident situation has been for the plane to circle the airport while the ground crews prepare a carpet of fire-fighting foam along the runway. The theory is that when the plane comes in on its belly the foam will dampen the sparking—thus preventing ignition of any fuel leakage—and reduce the friction between metal and pavement.

The procedure seems to work. In a scattering of highly publicized airplane crashes foaming the runway was given the major credit for safe landings in which the passengers walked away and the plane did not catch on fire. Yet, the technique was based almost entirely on supposition. For instance, a pilot adequately warned and with plenty of time to prepare for a belly landing usually jettisons his fuel, or uses it up, before setting down. So in many accidents no one really knew whether the foam prevented a fire or whether it didn't. Equally unknown was the true lubricating effect of the foam: did it actually "grease the runway," or did it only seem to?

Chemists and engineers from the Naval Research Laboratory, supported in their project by the Bureau of Naval Weapons, conducted a series of laboratory and field experiments to establish a scientific basis for an optimum technique of foaming runways.* This article concerns particularly the field tests, which were carried out on runways at NAS, Patuxent, Andrews AFB, and at NAS, Anacostia.

As illustrated in Figure 1, the apparatus for the spark-ignition tests consisted of a metal specimen or "shoe" (Figure 2), supported beneath a frame so that it could be dragged along the runway behind a 3/4-ton truck. Gasoline could be sprayed on the runway from a battery of six nozzles. A wire temperature probe could also be suspended to measure the temperature at which fuel ignition took place.

The tests were run at a uniform speed of 30 miles per hour (44 feet per second), alternately on the dry runway and in foam of various depth and aging—that is, length of time since laying. Eight types of metals commonly used in the aircraft industries were studied: one alloy each of aluminum, titanium, and magnesium; two steel alloys; two standard stainless steels, and one cold-rolled steel. Ordinarily gasoline (flash point -40° F) was used in most of the runs because it normally ignites just as quickly if not more quickly than aviation gasoline or jet fuel; however, JP-4 and JP-5 (common jet fuels) were also tested.

When the metal shoe was dragged on dry pavement, the stream of sparks almost always ignited the gasoline in a few seconds. On foamed pavement, the gas usually did not ignite; the exceptions occurred

*A great deal of prior, very informative research had been done by the National Advisory Committee for Aeronautics.

Figure 1--Rig for dragging metal specimens (or "shoes") along a runway showing metal "shoes," gasoline nozzles, and hot-wire probe for measuring ignition temperatures.

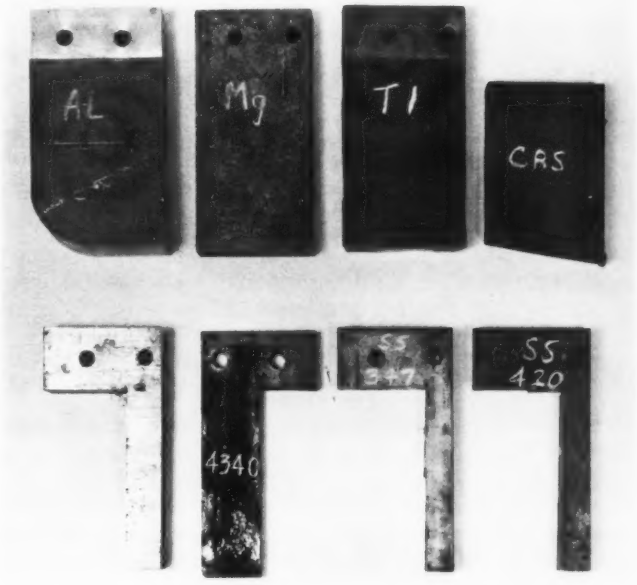


Figure 2--Metal "shoes" used in dragging tests.

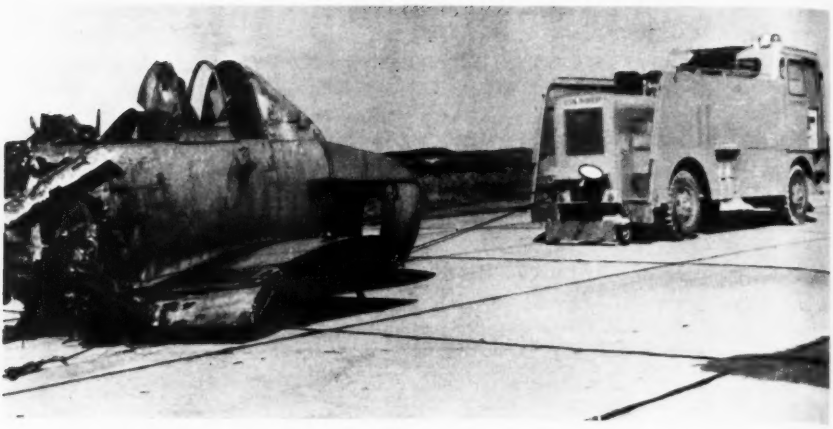


Figure 3--Aircraft towing tests showing hydraulic scale for measuring drag resistance

when the foam was sparse or had not aged sufficiently to wet the pavement—in these cases the gas ignited on top of the foam or in the trough cut by the shoe.

The tests to determine the lubricating effect of the foam were conducted simply by dragging a wrecked plane body along a dry runway (Figure 3) and then through a carpet of foam. A hydraulic scale, attached to the tow line, indicated only about 5 percent difference in drag between the two runways conditions. It is obvious, therefore, that the foam accomplishes very little in "greasing" the runway.

The scientists listed nine principal questions about the efficacy of foam when they began their investigation. These questions are enumerated below, together with the most conclusive answers elicited by the tests. It should be emphasized that the answers are very general, based on averages and subject to numerous exceptions introduced by different metals, types of runways, flammability of fuel, and depth and aging of the foam. They do, however, provide a well-tested basis for continued use of the foaming technique in belly landings.

Q: Does a layer of foam on a concrete runway produce a change in coefficient of friction for a sliding airframe part and thereby reduce damage due to lubricity or "slipperiness" effect?

A: No; there is a change but so small a percentage the effect is negligible.

Q: Can friction sparks of airframe metals contacting the surface be dampened or suppressed by foam so that ignition of fuel vapors is avoided?

A: Yes; in the test runs the effectiveness varied between 50 and 100 percent, but in 90 percent of the runs the effectiveness was 100 percent.

Q: Which is more effective, a higher-expansion viscous foam or a low-expansion fluid foam?

Figure 4--The MB-5 vehicle rigged for laying a foam strip, showing the spreader at the rear for smoothing the foam to a uniform depth. This vehicle loads 400 gallons of water and foams 4000 square feet of runway in 2 minutes. The MB-1, a similar vehicle with larger tanks, loads 1000 gallons (10,000 square feet).

Figure 5--A finished foam test strip, 4 feet wide by 400 feet long, laid on a concrete runway.

A: Expansion-viscosity doesn't seem to make much difference: what really matters is that the water content be sufficient.

Q: As a foam blanket ages, what happens to its effectiveness as a spark suppressant?

A: The foam should age long enough for water to settle onto the runway—10 to 15 minutes; it will remain effective for at least 2-1/2 hours.

Q: Will the foam endanger the aircraft by interfering with its braking or steering capability?

A: No; foam presents no more of a skidding hazard than a wet runway.

Q: With respect to friction sparks from various metals, which generates more hazardous sparks capable of igniting fuel vapors, an asphalt or concrete surface?

A: Rough concrete; there is little to choose between asphalt and smooth concrete.

Q: Of the common metals of aircraft construction is there a relative order of increasing (or decreasing) spark suppression capability by foam?

A: Yes; of the eight metals tested, aluminum does not spark at all, and cold-rolled steel very little, even on dry pavement; among the steel alloys and stainless steels the spark-inhibiting effect of the foam was about equal; the foam was least effective against magnesium and titanium, the latter hardly at all.

Q: If a runway is to be foamed, how long, wide and deep should the pattern be?

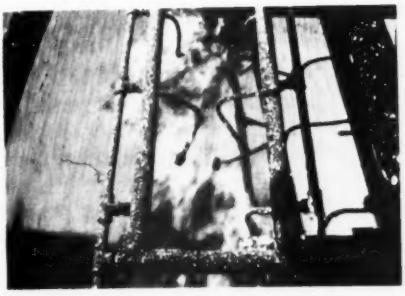
A: The one invariable factor is that the optimum foam depth should be 2 inches; the width and length of the blanket will vary with size and type of plane, landing speed, and configuration of the landing gear. Tables covering the varying conditions have been worked out. For instance, a 4-engine DC 7 landing on its belly would require a blanket approximately 75 by 2500 feet.

Q: With presently available equipment, how much time and material will be needed to lay this blanket of foam?

A: This depends on the number and type of apparatus available, length of run to water hydrants, and like factors. For the DC 7 landing cited above, it would take 18 loads for the MB-1 vehicle to lay the foam strip; 44 loads for the MB-5.

From the foregoing it is evident that proper runway foaming is excellent fire prevention when a landing gear fails to function. But foaming takes a great deal of time and an adequate on-hand supply of materials. It obviously cannot be done--effectively and while a plane is circling above an airport--unless there is careful planning, thorough preparedness, and excellent organization.

Figure 6--Foam pattern 60 minutes old, illustrating the complete lack of water runoff.



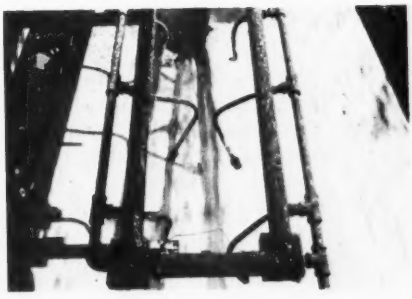


Figure 7 and 8--Evidence that the foam works: two motion picture frames of a drag-run through foam and immediately afterwards on dry concrete. Ignition occurred 2-1/2 seconds after leaving the foam.

Amputee Rehabilitation and Modern Artificial Limbs

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During the past 16 years, the Navy Amputee Rehabilitation Center—located at the U. S. Naval Hospital, Oakland, California—has treated over 7000 amputees. The majority of these cases have been battle casualties from World War II and the recent Korean conflict. But some of these amputations have resulted from frostbite, operational and industrial accidents, motor vehicle mishaps, vascular dieases, and bone tumors. Patients in all groups, from infants to those over 90 years of age, have been fitted and successfully trained in the use of artificial limbs.

The ultimate goal of the handicapped is proper job placement, and an employed rehabilitated individual assumes the position of being a contributor and an asset rather than a liability and dependent upon charity for a livelihood. From an economic viewpoint, rehabilitation represents a sound investment. Instead of becoming a burden upon the taxpayer, the employed handicapped individual becomes a taxpayer.

THE REHABILITATION PROGRAM

Since the establishment of the Center early in World War II, it was recognized that a full rounded program—employing all the resources of medical science and the various allied specialties, such as physical therapy, occupational therapy, and vocational training—was necessary for proper and total rehabilitation. Thus, a seven-point program directed toward the complete rehabilitation of the individual patient has been established at the Center.

Adequate Medical and Surgical Care. On the average, two surgical operations are required to prepare the amputated stump for fitting with a prosthesis. With modern surgical techniques and anesthetics, chemotherapy, and the massive use of whole blood, the mortality rate from amputation surgery at this activity has been a fantastic zero. The surgeon today preserves stump length whenever living soft tissue is present. Because of improvements in artificial limbs, special types of prostheses can be fitted to long stumps. The advantage of long-lever action, preservation of muscle length, gives a long stump a decided advantage over a short stump from the standpoint of function. The most common serious complication is postoperative hematoma (a tumor or swelling) in the stump.

Preprosthetic Physical Reconditioning of the Entire Body and Stump. In the immediate postoperative stage, proper bed posture, muscle exercise, and early ambulation are employed. This counteracts contractures, improves general well being, strengthens the body, and helps overcome the depressive mental state that is often prevalent

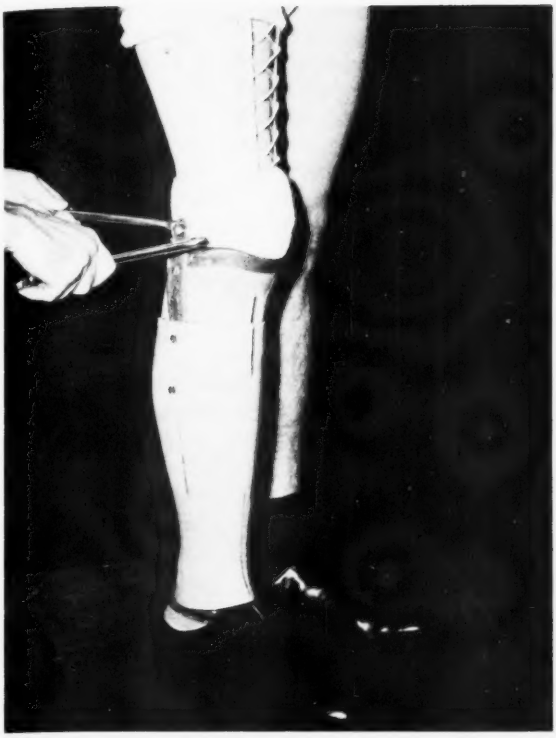

Figure 1--Fitting a limb with a modern, comfortable prosthesis.

following amputation surgery. As soon as sutures are removed, a more active physical reconditioning program is individually prescribed together with more intense stump exercises. The stump is shrunk by means of an elastic bandage in order to remove the postoperative edema (abnormal accumulation of fluid in the connective tissue).

Fitting With a Modern, Comfortable Prosthesis. As soon as the surgical incision is healed, the patient is fitted with a suitable prostheses. (See Figure 1.) Fittings are done on the average of three to six weeks postoperatively, and although the stump is rapidly undergoing shrinkage, adjustments and new sockets are provided in order to maintain the fit of the rapidly changing stump size. Light-weight prosthetic limbs with functional joints and soft flexible plastic sockets allow the amputee to wear and utilize the prosthesis at an early postoperative stage.

Training in the Use of the Artificial Limb. Walking training is provided by the Physical Therapy Department, and supervision and instruction are given by qualified teachers who are also amputees. The training program is individually prescribed for the patient from the first procedures, such as weight-bearing, correct body posture, swinging the prosthesis, and walking between bars (Figure 2), to the more advanced training on ramps, stairs, obstacle courses, dancing, and in the proper operation of an automobile. Arm cases are trained

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with the artificial limbs in the Occupational Therapy Department by an amputee instructor who can demonstrate to the patients the use of his own artificial limb. The patient is taught to use both the hook and artificial hand and is trained in the use of the prosthesis in practical needs, such as dressing, personal care, eating, and typing, and in various forms of work and recreation. Ward rounds and weekly amputee clinics are held by the joint staff where the amputees demonstrate their progress and efficiency with their artificial limbs. The training is culminated by an achievement test which each patient performs according to his remaining ability.

Psychological Adjustment and Aids to the Handicapped. Psychological conditioning and the patient's acceptance and adjustment to his handicap are important milestones in the program of rehabilitation. Whenever possible, a presurgical conference is held, and explanations of the reasons for surgery are given along with a demonstration by an amputee of the type of limb that will be provided. Amputee cases are

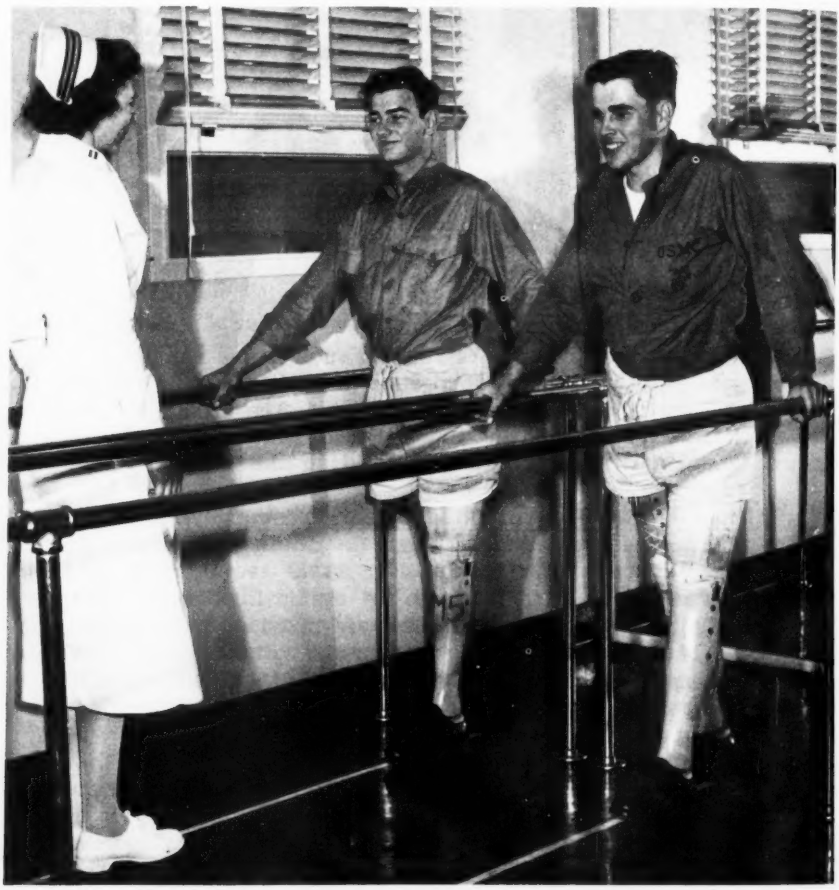

Figure 2--Learning to walk between bars.

hospitalized in an amputee ward where they have the opportunity of viewing other amputees in the various stages of their program. Motion pictures of the complete program are shown to the amputee post-operatively in order that he will fully understand what he may expect and accomplish in the rehabilitation program. Group therapy lectures where the patients can informally ask questions and discusss their individual problems are held. Throughout the entire program each member of the staff is constantly helping the patient individually gain confidence and adjust to his disability. Private discussions with the Medical Officer are held in order to render aid and explain the many and varied personal problems that may be troubling the amputee.

Prevocational Training and Education. Aptitude testing and vocational counseling are given, in order to determine the qualifications of the patient. Prevocational training may be given and started while the patient is still under hospitalization, or it may be inaugurated or continued through the auspices of the Veterans Administration or State Vocational Rehabilitation Service, after the patient is discharged from the sick list. Whenever feasible, the younger amputees are advised to continue their education through the university level for future preparation of their life's work.

Proper Job Placement. Some amputees can return to their former employment. And there are cases who can be successfully employed in their vocation, provided the type of work is varied to their individual remaining ability. Employers are gradually recognizing that the handicapped person, employed in the right job, is a decided asset to their organization. Job placement may be procured directly upon discharge from the hospital or through the services of Government Employment agencies.

RESEARCH AND DEVELOPMENT ON PROSTHETIC DEVICES

In conjunction with the rehabilitation treatment, a program of research and development on prosthetic devices is conducted at the Center. The facilities for research and development work are ideally provided for in a center. Competent research on artificial limbs requires the services of specialized personnel—including the physician, engineer, and the limb fitter—and facilities for training amputees. Careful evaluation of both patient and new prosthetic devices is needed and, above all, a pool of clinical cases who can provide the practical testing of the artificial limb under complete field conditions. Research work on prosthetic devices is difficult and time-consuming because scientific evaluation of a given improvement in an artificial limb requires, at a minimum, 100 cases and a period of use of at least one year. The research program at the Center includes over 30 individual research projects on both artificial arms and legs. Techniques of fitting alignment, including the various components on artificial arms and legs, and the use of the latest metal alloys and plastics (Figure 3) are studied. The research has especially stressed proper fitting of the stump, alignment of the limb, selection of materials from which a comfortable socket can be fashioned, the development of functional-type joints, reduction of the total weight of the prosthesis, cosmetic appearance, and durability and economy of prosthetic service.

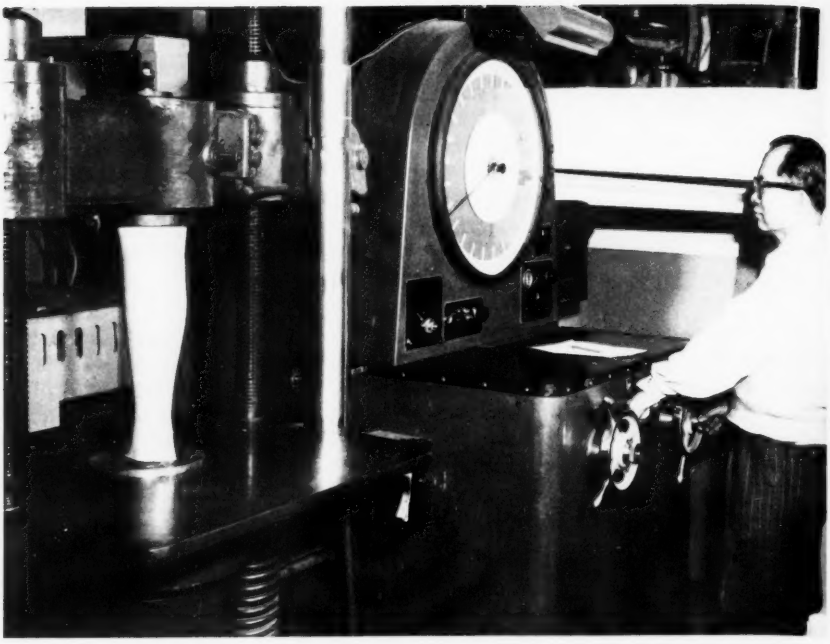

Figure 3--Testing the strength of a plastic leg.

THE RESULTS OF PROPER REHABILITATION AND TREATMENT

An analysis of a case study of 402 amputee patients revealed that only 24 cases (6 percent) are either unemployed or not wearing their prosthesis. Of the successful group, 94 percent are in all types of occupations and vocations. Amputees are successfully employed in almost every type of work, representing the alphabetical listing from accountants to zoologists.

The results of amputee rehabilitation treatment reveal that when amputees participate in a comprehensive rehabilitation program, are fitted with comfortable, modern prostheses, receive prevocational training, and have individual assistance in securing proper job placement the majority of cases become participants and contribute to our way of life as effectively as any other group of citizens.--Military Medicine.

President-Elect

CAPT James A. English, DC, USN, Head, Medicine and Dentistry Branch, Office of Naval Research, has been elected to the office of President-Elect of the International Association for Dental Research. The election was held recently in Chicago.

The IGY and Mean Sea Level

Dr. June G. Pattullo
Scripps Institution of Oceanography
University of California
La Jolla, California

BOAT SINKS WITH THREE ABOARD ONE MILE OFF TAKAROA TWO BT* ONE BOAT ONE MOTOR ONE BT WINCH ALL LOST NO LIVES LOST DESPITE STRONG OFF-SHORE CURRENT NEED NEW STERIC EQUIPMENT

This message, received at Scripps Institution just before Christmas 1957, nearly meant the end of our IGY † observational program in the Tuamotuan atolls of French Polynesia. It nearly meant the end of the three men, too; Tuamotuans have a long collection of stories of loss of life or limb to the man-eating sharks in the area. In this case, however, the two younger men (one American, one Polynesian) made it to shore after two hours of swimming and then went back in an outrigger canoe to rescue the older man, who had been clinging to an equipment box. This rescue was a bit of a miracle. Certainly it demonstrated the Polynesians' good sense: they found him by following an oil slick down current from the approximate spot of the accident.

What were these men doing out there in the first place? They were taking part in an ocean-wide survey of temperature and salinity conditions for use in conjunction with the study of mean sea level variations during the International Geophysical Year.

The study of sea level has a long history, but it still presents many unanswered problems. It is, of course, well known that the sea surface is seldom horizontal and virtually never stationary—it hardly takes a scientist to tell this to a Navy man! But why does the sea surface gradually change elevation throughout the year at any given point? And what connection is there between the variations in level at, say, Hawaii and San Francisco?

One of our problems in tackling this study is that the instrument ordinarily used—a tide gage—has to be attached to land, and this, of course, presents difficulty in the open sea. There, are, however, little patches of land here and there at sea—particularly in the tropical Pacific—that can serve as instrument platforms. These oceanic islands have not been extensively used in the past because they are frequently difficult to get to, expensive to supply, and are controlled by more than a dozen different nations. Previously, it had been something of a major organizational job to get observations simultaneously at enough of these pinpoints to aid materially in the network of data. Now the

*Bathythermograph, a kind of sea-temperature thermometer.
†International Geophysical Year.

IGY provided the golden opportunity to meet this need. Not only professional scientists, but intelligent people everywhere knew about this year of ambitious scientific cooperation.

But would these people help, as individuals? Extending the network of sea level observations out to sea meant setting up instruments on remote islands where few ships call. It meant asking the help of the people already in these out-of-the-way places. Would they help us get to their islands, land, and install our equipment? Would they volunteer to tend the gages, make the time marks, and every two weeks go out in small boats to collect temperature and salinity data? They would, they could and they did—and to this cooperation goes the credit for the success of the observational work.

First of all, nothing could have been done without the generous assistance of local authorities and businessmen concerned with each place. As it turned out, virtually every country with government on or control of a Pacific island established at least one new observational station. This meant that men from more than a dozen countries worked together from the first discussions four years ago to the publication of the data in January, 1960. In many cases, one nation or group supplied the equipment, another the personnel, and still a third the transportation. French, British, Mexican, and Ecuadorian authorities and private companies actively assisted some of our own Scripps personnel in the field; the U. S. cooperating agencies who made major contributions include the Navy, the Weather Bureau, the Coast and Geodetic Survey, and the Fish and Wildlife Service.

The most important man to the survey was the individual observer. On Arorae, a small speck of British land just south of the Equator in

Figure 1--Site of tide gage station, Guadalupe.

the western Pacific, Neemia Matiota and his Gilbertese neighbors kept a tide gage working for more than two years. Five hundred miles to the west Captain Steve Dexter, with the assistance of the British Phosphate Commissioners, ran what is probably the best complete station of the Scripps-operated stations: Ocean Island, where both sea level and temperature and salinity observations were observed for more than two years. A couple of thousand miles southeast of these two, a French citizen of Tahitian-Polish ancestry, Malinowski by name, found time between his duties as weather observer, radio, operator, and postmaster on Rurutu to take a good series of both kinds of data at that hilly green island. A young man working on Guam as Observer in Charge of the U. S. Coast Survey's geomagnetic station received a box of equipment from us and then wrote us a puzzled letter asking what to do with it. We explained to our embarrassment that our supposed arrangements had somehow gone awry; nevertheless Dave Newman agreed to take the boat observations we requested and did a first-class job. The list of those cooperating is a long one; Scripps was involved in more than 20 observational stations, and each one was a special case. Also special recognition for the success of the survey goes to such people as Weather Bureau Meteorologist Berger on Wake, Chilean Navy men Peralta and Sievers supervising work on Easter and Juan Fernandez islands—and Floyd McCoy and his fellow Pitcairners. Conditions were not always ideal at any of these places. A photograph (Figure 1) taken by the Officer in Charge of the Mexican Navy station on Guadalupe shows the tide-gage site there.

This really warm cooperation on virtually all sides was a pleasant surprise to us, because at first glance neither the observational work nor the immediate results could possibly seem glamorous to the layman. The data flowed in by plane and ship, on rolls of paper, and in boxes of bottles—and even as curves scratched on small glass slides. And while we at Scripps were involved in the work only in the Pacific, similar if not as extensive work was done in other oceans. Now, however, the stations are all closed down, the last tide roll is being read, and the last salinity sample has been chemically analyzed.

Was the survey worth all the effort? Well, we think that we have learned a little. For example we are now able to detect, for the first time, that the central Pacific Ocean behaves differently from the coastal regions. True, all of the Northern Hemisphere seems to show high sea level in September, except some areas lying between 40° and 60° N (Figure 2). This had been anticipated from earlier work. But look at Figure 3. All of the central Pacific and most of the central Atlantic, both north and south of the equator, has high levels in December while at the same time areas near the coasts, particularly in the tropics, are lying at lower than usual levels. Furthermore, the Arctic—now for the first time adequately ringed with gages—displays a pattern of its own (Figures 4 and 5). In September the ocean stands high; in March, low, more like the subtropical area near Hawaii than like the subarctic region of the Aleutians. During December and June, however, this ocean seems to split into two separate zones. Levels are high in the Chuckhi Sea and low in the Norwegian Sea in June; conditions are just the reverse in December.

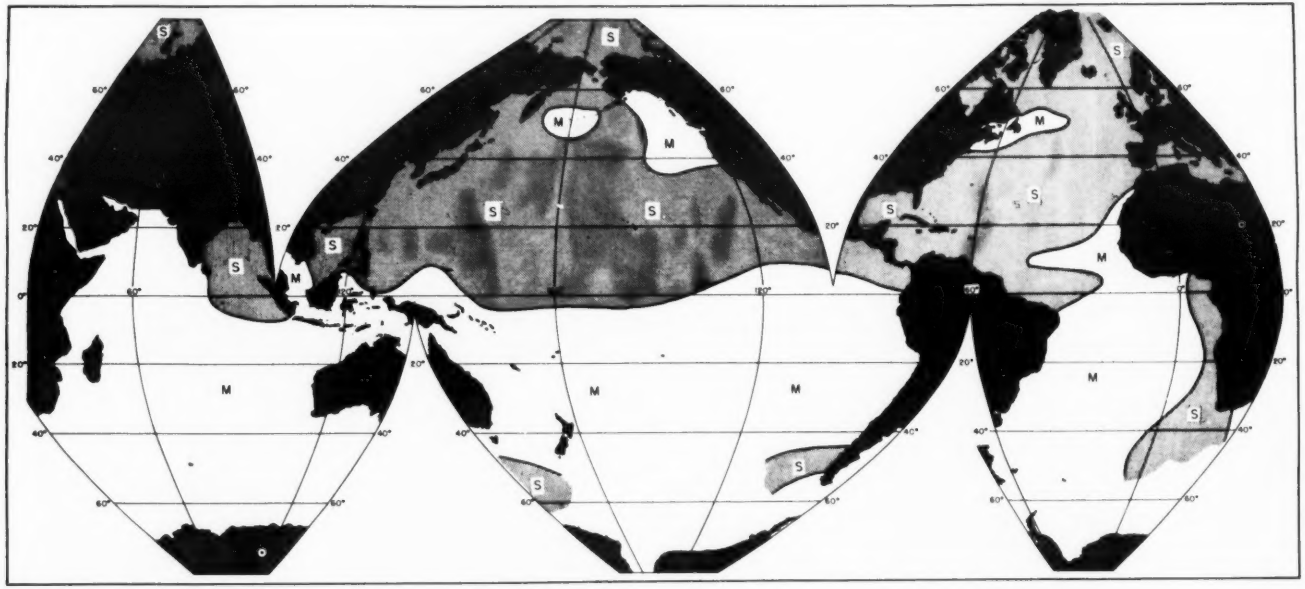

Figure 2--Mean sea level deviation during spring and fall. Areas are shaded and labeled "S" if sea level is higher than average during September, unshaded and labeled "M" if higher than average values are observed in March.

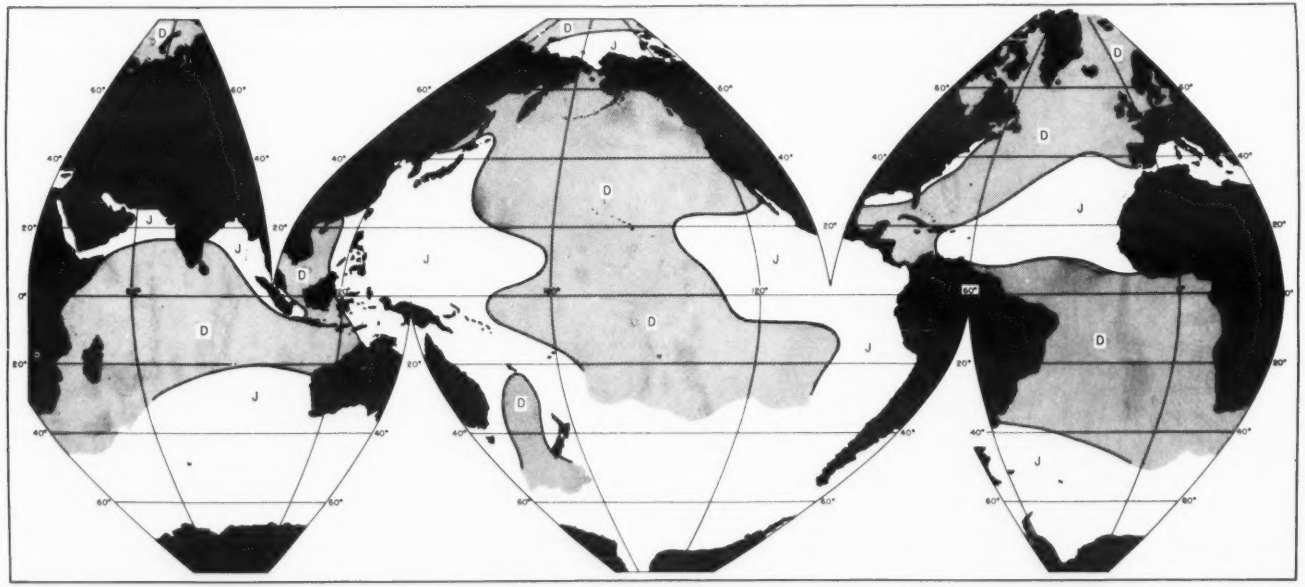

Figure 3--Mean sea level deviation during summer and winter. Areas are shaded and labeled "D" if sea level is higher than average during December, unshaded and labeled "J" if higher than average values are observed in June.

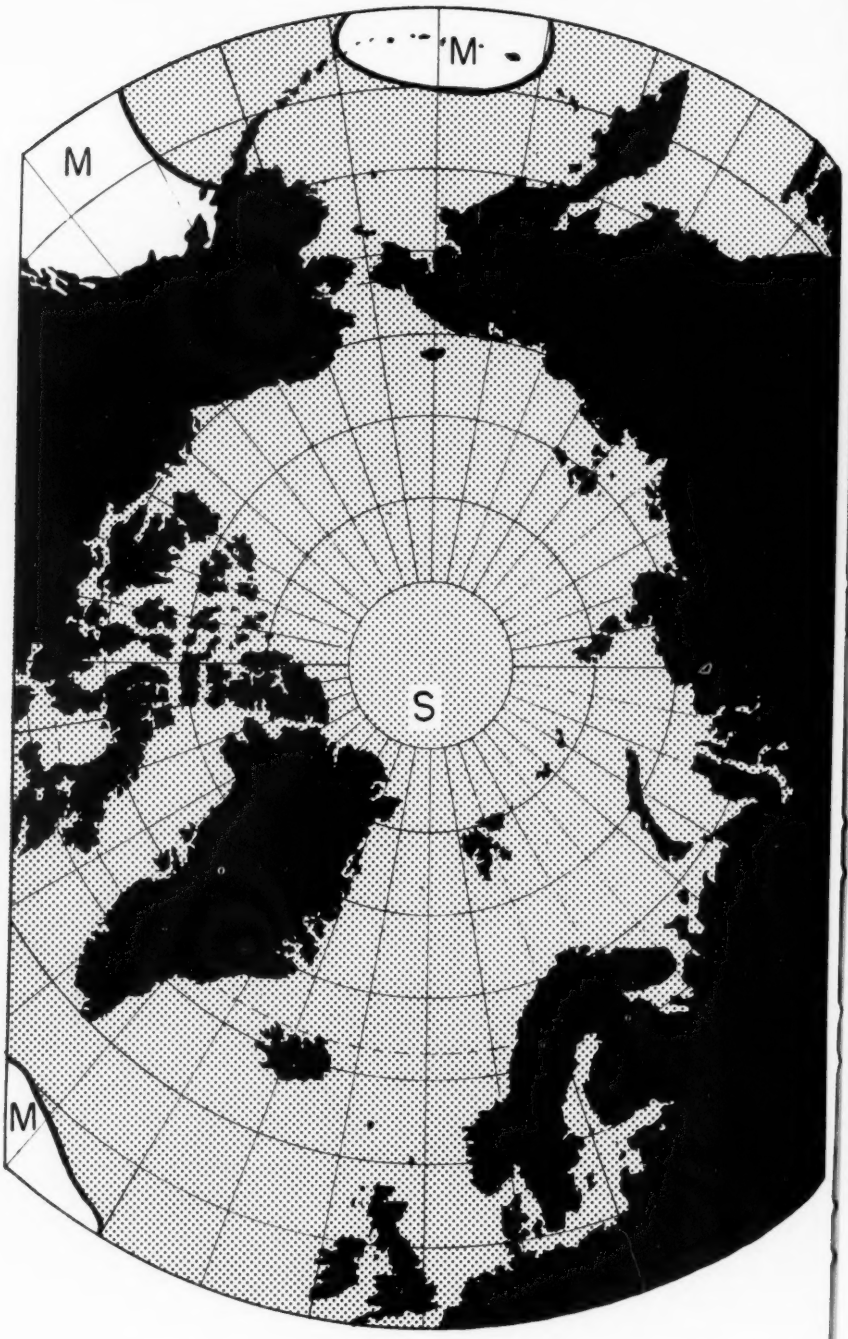

Figure 4--Sea level deviation in the Arctic during spring and fall.

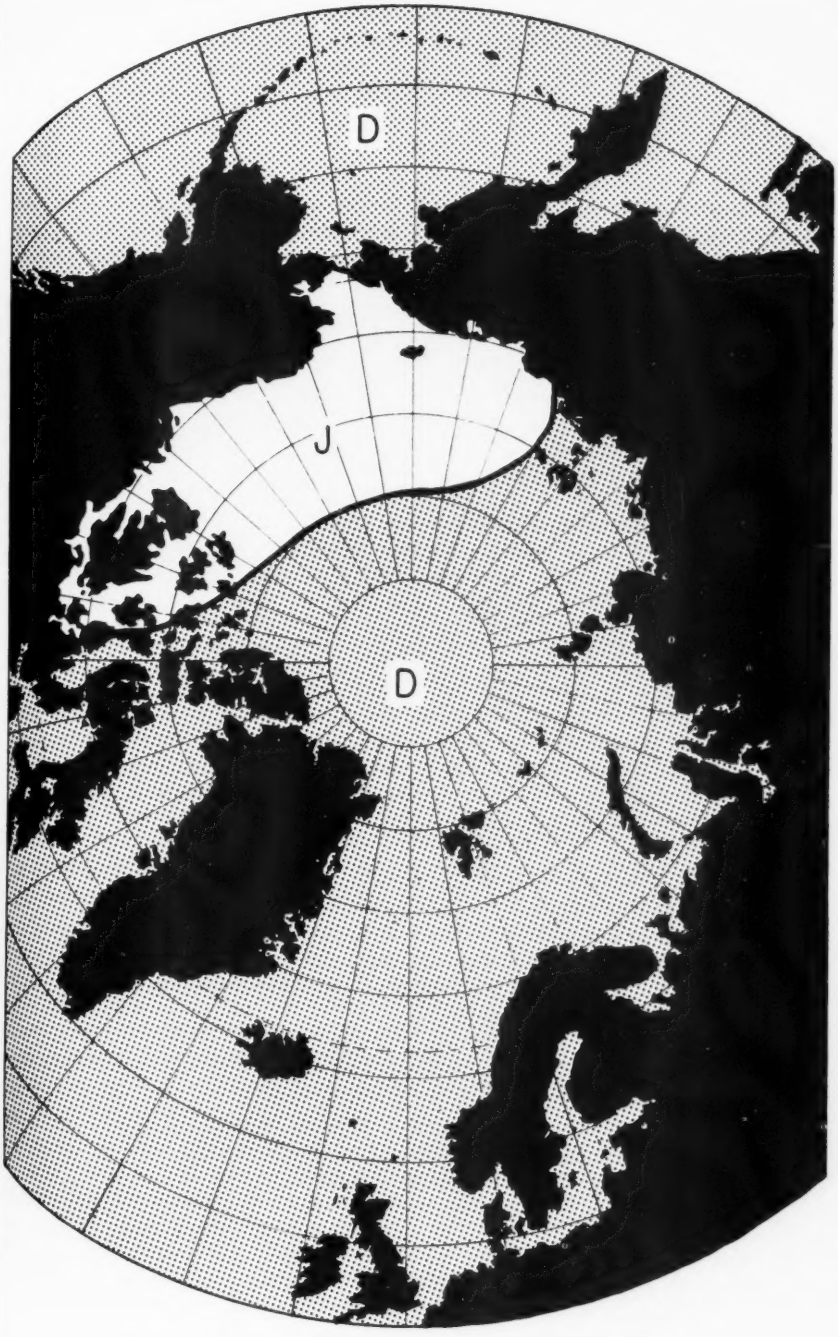

Figure 5--Sea level deviation in the Arctic during summer and winter.

We have also learned that our earlier land-locked estimates of the magnitude of the variations were, for average conditions, too high. The coastal data consistently shown larger ranges of level than the offshore islands; our present best guess is that for the mean sea level as a whole an average annual range of only 10 to 15 centimeters, or a little less than half a foot, is representative.

By now you may be wondering what all this has to do with the three men in the boat. While we were getting world-wide measurements of sea-level changes, we were also trying to collect some information on the causes of the changes. The boat observations were needed to that we could observe changes in temperature and salinity of the water throughout the year and, by using these, compute the seasonal changes in the volume of the water. Since water expands when it heats, we know the sea level rises when the water warms up. Similarly, lower salinities are reflected in higher sea levels. For either of these factors to be very important, we had to have deep water near our gages, since the changes per cubic foot are very small.

The results in the Pacific show that the September high levels throughout subtropical regions in the Northern Hemisphere (and the March high levels, south of the equator) are related to this effect, and the principal source of the increased heat is from local heating (solar heating during summer, cooling by evaporation during winter).

Farther north, near the Aleutians, the seasonal changes in heating are small, and the high levels observed there in December are caused principally by seasonal variations in atmospheric pressure in the stormy area of the Aleutian low-pressure cell. The sea responds roughly like a barometer turned upside down; if the air pressure goes up one millibar, sea level goes down a centimeter, etc.

Other variations are not so simply explained. Sea level is high in midocean near the equator in December, but not to the east and west. Why? Here again increased volume of water related to the presence of warmer water in midocean seems suggested: this is probably not due to variations in local heating, but to the transport of water in and out of the region.

Let's consider another thorny problem: What's going on in the Arctic? Neither pressure nor temperature effects are large. It is possible that seasonal changes in salinity caused by variations in runoff and ice melt may be responsible for the observed changes in level. Perhaps there is simply more water in the Arctic at one time of year than another, or that the water is pushed out toward the edges during one season. Data are now being analyzed in an attempt to test these possibilities. Furthermore, it is puzzling that vitually all over the globe the variations at the coastlines of the continents are larger than they are offshore. Perhaps the wind is "piling up" water along the coast. Perhaps a current sets along the coast more vigorously in one season than in another. Ocean currents and the slope of the sea surface perpendicular to the flow of water are inextricably related, and—except in steady slow currents in deep water—the relationships are not explicitly known.

No, our work cannot be considered finished now that IGY is over. We are, in fact faced by increasing demands on our ability to describe and explain what is happening. The geodesists, for example, want to expand their knowledge about the shape of the earth's surface; the seas make up three-fourths of that surface, and geodesists can ask the most unanswerable questions!

This summer, at international meetings in Finland, oceanographers who study sea level are going to try to coordinate some of our observations with those of the geodesists who study the shape of the earth's surface. They hopefully use "sea level" as a reference; we, equally hopeful, use "fixed bench marks" attached to the earth. As a result of these "one-way" approaches we have finally bumped into each other moving backward.

Computer Beats Admirals at Checkers

At a recent seminar on advanced information systems and artificial intelligence held by Flag Officers in the Navy Supply Corps, an IBM 704 Computer had an easy time beating the Admirals in a checker game.

The game was used to demonstrate the power of an "heuristic" machine program which includes a learning factor. Before each move, the computer looks ahead anywhere from 3 to 20 moves, and evaluates various positions by a position score which depends on up to 38 factors. Because the machine "learns" from experience, it has progressively improved its game until it now wins most of the games it plays against the IBM scientist, Dr. Arthur Samuels, who originally designed the heuristic program for checkers.

Among the other topics, the Supply Corps Admirals reviewed the use of cryogenic and thin-film techniques in data-processing systems; recent advances in the theory of communications linkages; practicality of real-time, data processing systems (such as IBM's SABRE system used for air-line reservations); concepts of very large multiple unit computers (such as STRETCH and HARVEST); and recent advances in programming. —ONR, New York.

A grandson of Thomas Alva Edison initialed the keel plate of a nuclear submarine Groton, Conn., March 15, which will be named in honor of the famed inventor. Peter Edison Sloane, 32, donned welder's garb and burned P. E. S. into a steel keel plate. The submarine is the second of a new class of Fleet Ballistic Missile Submarines. The first, the ETHAN ALLEN, us under construction on adjacent ways. All Polaris-firing submarines are named in honor of Americans known for their dedication to the cause of freedom.

Oceanographic Expedition of The Survey Ship EXPLORER

An extension of pioneering work in the development of equipment and techniques for making oceanographic investigations is underway aboard the Survey Ship EXPLORER (OSS-28), which began an extended oceanographic cruise the first of February from Seattle, Washington, to the East Coast, via the Panama Canal. This is the most comprehensive oceanographic expedition undertaken by the U. S. Coast and Geodetic Survey since the early 1880's, when the Coast Survey Ship BLAKE made surveys which are now of great historical value. The expedition is supported in part by the National Science Foundation with a dozen or more research organizations participating. Dr. Harris B. Stewart, Jr., Chief Oceanographer of the U. S. Coast and Geodetic Survey, is the scientific director of the expedition.

Under the command of CAPT E. L. Jones, USC & GS, the explorer is one of four modern survey ships now in use by the Coast and Geodetic Survey. The ship was built for service in the Alaska survey fleet, but is now assigned to service along the East Coast of the United States. Transfer time from the West Coast was extended by more than two months to allow for investigations of various oceanographic features along the rutes.

On the early agenda of the expedition, observations were made at eleven positions off the coast of Oregon by the Scripps Institution of Oceanography cooperating with Oregon State College. At each station water samples were taken to study the distributions of salinity, dissolved oxygen, phosphate, and temperature. Other important data were collected to determine the oceanographic regime, or makeup, off this coast. In addition, surface water samples were taken, and the suspended sediments will be studied to determine what becomes of Columbia River water once it enters the Pacific Ocean.

A magnetometer, provided by Scripps at San Diego, California, was towed behind the EXPLORER to record continuously the earth's magnetic field along the ship's course. This information, when studied in connection with documented data on bottom topography, will add considerably to man's knowledge of the intricate magnetic field of the earth. If the magnetometer discovers unsuspected or unexplained magnetic "hills" or "valleys," the ship's plans are flexible so that extra time can be taken to survey the area in more detail.

Scientists from the U. S. Navy Electronics Laboratory, San Diego, brought along deep-sea camera equipment for photographing the ocean bottom off the West Coast of Central America. They will attempt to prove photographically whether or not the ocean bottom at this location is covered with 80- to 100-percent nodules of manganese, high in nickel and cobalt.

While the EXPLORER was in the area of Swan Islands, the Census Bureau representative aboard completed the 1960 census there. These islands lie on the southern edge of the Cayman Trough, about 100 miles northeast of Honduras and are perhaps the least-known possession of the United States. Plans have been made for the reconnaissance survey of these poorly charted islands which include charting and mapping, coring (taking core samples), and dredging. Divers explored the ocean bottom, the fish, and marine plant life around the Islands, and photographed the various activities.

The shelf around the Swan Islands was extensively studied. These limestone islands cap a small bank that drops off abruptly to the north, attaining depths of over 3000 fathoms (18,000 feet) in the Cayman Trough. Scientists will attempt to ascertain whether these islands are related to the complex of cays (small islands) and banks off Honduras or if the origin is structural and related to the massive Cayman Trough. In addition to a geological survey of the Islands which will be conducted later by the Geological Survey of the Department of the Interior mammals, reptiles, and insects were collected on the Islands for the U. S. National Museum of the Smithsonian Institution.

Meanwhile the Fish and Wildlife Service conducted dredgings to recover bottom-dwelling animals in the Carribbean and also in the Straits of Florida. Samples of ocean-bottom sediments were collected for the U. S. Public Health Service; in turn, these samples will be tested for radioactivity as part of the Health Service's radio chemical surveillance program. Also, a meteorologist assigned to the expedition by the Weather Bureau, Department of Commerce, studied the upper atmosphere by sounding balloons released at regular intervals.

Ocean observations similar to those constructed off the Oregon coast were made at regular intervals in the Pacific, the Carribbean, the Gulf of Mexico and along the Atlantic Coast, Ocean temperature was taken each hour throughout the expedition. A special instrument provided oceanographers with a profile of temperature versus depth.

Measuring the speed and direction of the Gulf Stream—not only at its surface but at depths of 1500 feet—was an important activity of the expedition. Observations of this "river of the sea" were made at the same location where Lieutenant Pillsbury, commanding the Coast Survey Ship BLAKE, made his time-honored observations. These observations are being made with newly developed equipment, utilizing greatly improved techniques and providing a striking contrast to the crude and time-consuming methods of Pillsbury's day.

The Navy Study Group on Shipbuilding and Modernization — composed of engineers, scientists, and industrial leaders from universities and industry — has begun a study of the present and future composition of the Fleet and its future shipbuilding and modernization plans. Under the sponsorship of the National Research Council, the group will explore possible development in new types of ships such as the deep hull, sonar types, hydrofoil ships, and new submarine designs.

Research Notes

UK and USA Begin Coordination of Time and Frequency Transmissions

The United Kingdom and the United States have begun coordination of their Time and Frequency transmissions. This was announced jointly in Washington by Dr. James H. Wakelin, Jr., Assistant Secretary of the Navy (Research and Development), Dr. Allen V. Astin, Director of the U. S. National Bureau of Standards, and in the United Kingdom by the Astronomer Royal, Royal Greenwich Observatory, and the Director of the National Physical Laboratory.

Coordination was begun in January to help provide a uniform system of time and frequency transmissions, which is needed in the solution of many scientific and technical problems in such fields as radio communications, geodesy, and the tracking of artificial satellites. Participating in the project are the Royal Greenwich Observatory, the National Physical Laboratory, and the Post Office Engineering Department in the United Kingdom, and, in the United States, the U. S. Naval Observatory, the Naval Research Laboratory, and the National Bureau of Standards. This program follows previous cooperative efforts of these agencies to achieve uniformity and simplification in procedures.

The transmitting stations which are included in the coordination plan are GBR and MSF at Rugby, England, NBA, Canal Zone, WWV, Beltsville, Maryland, and WWVH, Hawaii. It is expected that by the end of this year the time signals from all the participating stations will be emitted in synchronism to the thousandth of a second. Such accuracy has been needed for some time in tracking artificial satellites on a world-wide basis.

Navy Scientists Elected to Nat'l. Academy

On 26 April 1960 thirty-five distinguished scientists were elected to membership in the National Academy of Sciences in recognition of distinguished and continuing achievements in original research. Not one but two scientists from the Naval Research Laboratory were elected to membership; they are Dr. Herbert Friedman, Superintendent of the Atmosphere and Astrophysics Division, and Dr. Richard N. Tousey, Head of the Rocket Spectroscopy Branch of the Astrophysics Division.

Dr. Friedman, 43, at NRL since 1941, has been engaged in the study of radiation emitted by the sun and its effect upon the upper atmosphere by means of rockets to carry specially designed instruments which detect radiation above the atmosphere. Such studies have contributed greatly to understanding Lyman-alpha and X-ray radiation and their effects upon the ionosphere.

Dr. Tousey, 51, came to NRL in 1941 and initiated a program of upper atmosphere research. At the inception of rocket research in 1946, he undertook a program of rocket spectroscopic work that contributed greatly to knowledge of the solar spectrum. He also guided research on the visibility of earth satellites and was a member of the Science Program Committee of Project Vanguard.

On the Naval Research Reserve

CAPT Jockusch is New Special Assistant (Research Reserve)

CAPT Julius W. Jockusch, Jr., USNR, relieved CAPT John P. Aymond*, USN, as Special Assistant to the Chief of Naval Research (Research Reserve) on 6 April 1960. CAPT Aymond has reported to the Chief of Naval Operations for duty in the Office of the Inspector-General of the Navy.

Prior to reporting to ONR, CAPT Jockusch was Assistant for Naval Reserve Policies (Legislation) in the Office of the Assistant Chief of Naval Operations (Naval Reserve). He reported to that assignment in 1956 after three years on the staff of Commander in Chief, U. S. Pacific Fleet, as Civil Affairs/Military Government officer, concerned with the administration of Pacific Ocean areas where the Navy has jurisdiction, and with military government war planning.

Capt. Jockusch

During the period 1950 through 1952, while serving in the Office of the Chief of Naval Operations, CAPT Jockusch had an active part in the development of the Armed Forces Reserve Act.

Among various assignments in World War II, he was Executive Officer of the Recruit Training Command, U. S. Naval Center, Sampson, New York, and subsequently was Commanding Officer of the Naval Personnel Separation Center at Sampson.

CAPT Jockusch is a native of Galveston, Texas, and was educated at Ball High School, Galveston, the Rice Institute, Houston, and the University of Berlin. He is well known within the Naval Reserve both among active duty and inactive duty Reservists.

New Training and Liaison Officer Reports for Duty

CDR Robert N. Jennings, USNR, reported to the Officer of Naval Research on 4 April 1960 for duty as Training Officer for the Research Reserve Program and as Fifth and Sixth Naval District Research Reserve

*See Naval Research Reviews, p. 22, March 1958.

Liaison Officer. He relieved CDR W. C. Avery, USN, whose next assignment is with the Joint United States Military Advisory Group in Athens, Greece.

CDR Jennings received his commission as Ensign, United States Navy, upon graduation from Midshipman's School at the University of Northwestern in January of 1942. He served in various harbor-defense billets, including command of a net-layer in the South Pacific during World War II. He served on active duty again during the Korean conflict, and has had two extended reserve assignments since, the most recent being command of the Naval and Marine Corps Reserve Training Center at Toledo, Ohio.

CDR Jennings

Selections for Promotion in Staff Corps

The March issue of Naval Research Reviews listed line officers of the Research Reserve who were selected for promotion to the grades of Captain and Commander. The Chief of Naval Personnel subsequently released the names of officers selected for Captain and Commander in the various staff corps. Congratulations are extended to these officers, who are listed below along with their respective companies:

FOR CAPTAIN

Medical Service Corps

Stanley F. Bailey	NRRC-12-6
Elon E. Byrd	NRRC 6-9
Barry G. King	NRRC 5-10
Philip S. Lawrence	NRRC 5-10
Donald MacCreary	NRRC 4-5

Civil Engineer Corps

Andrew A. Brown	NRRC 5-6

Medical Corps

Lee E. Farr	NRRC 3-9

Supply Corps

Richard C. Foley	NRRC 1-3
Clayton R. Tidyman	NRRC 12-4

FOR COMMANDER

Medical Service Corps

Rollin H. Baker	NRRC 9-16	Joe J. Lehman	NRRC 11-3
William G. Eden	NRRC 6-2	Ivan N. Mensh	NRRC 9-12
Lorraine Friedman	NRRC 8-1	William G. Roessler	NRRC 5-3
James F. Haggerty	NRRC 5-10	Fred L. Schaffer	NRRC 12-5

FOR COMMANDER (Continued)

Medical Corps

Thomas S. Ely NRRC 5-10
James M. McClamroch NRRC 6-4
Walton W. Shreeve NRRC 3-9

Supply Corps

William V. Crowley NRRC 11-3
Lewis F. Roth NRRC 13-5

Civil Engineer Corps

Robert L. Elgin NRRC 9-9

Reserve Assistant Reports in New York

LCDR Arnold Brandt, USNR, reported for duty as Assistant for Research Reserve at the Office of Naval Research Branch Office, New York, on 27 February 1960. LCDR Brandt relieved LCDR William B. Lower, USN, who has reported for duty as Officer-in-Charge, U. S. Naval Radio Facility, Londonderry, Northern Ireland.

LCDR Brandt graduated from the New York State Merchant Marine Academy in 1944. His most recent assignment, prior to reporting to ONR, New York, was Commanding Officer of the Military Department aboard the USNS GENERAL ROSE, a MSTS transport.

LCDR Brandt

Commanding Officers' Conferences

Conferences for Commanding Officers of Research Reserve Companies were held during the latter part of March at Boston, Massachusetts (First Naval District); Great Lakes, Illinois (Eighth and Ninth Naval Districts); San Francisco, California (Twelfth Naval District); and Seattle, Washington (Thirteenth Naval District). The conferences were organized and conducted by the Reserve Assistants of ONR branch offices in those cities in cooperation with the Commandants of the Naval Districts. All were two-day weekend conferences, with the exception of the one at Boston, which met on Saturday only.

These meetings were comprehensive briefings, designed to acquaint the commanding officers with the current policies and special problems of the Research Reserve. The agenda included administrative regulations concerning training, drills, and appropriate duty; training duty opportunities; the Research Reserve curriculum; promotion policies; mobilization concepts and policies; patent activity training; pay billets; security regulations; Research Reserve projects; membership recruitment; preselection for mobilization billets; and other pertinent subjects.

The Great Lakes Conference was led by CDR L. P. Hoskins, USNR, Research Reserve Program Officer. The speakers from ONR Washington were CAPT J. P. Aymond and LCDR Eleanor Kehoe. The solid work at this meeting was lightened occasionally, by the Navy Seapower Presentation, by briefing report movies on Navy research and development, and by postconference tour of the Argonne National Laboratory.

The San Francisco Conference, which met at Treasure Island, was planned and arranged by LCDR H. A. Wellemeyer, USN Research Reserve Program Officer for the Twelfth Naval District. Miss Kehoe represented ONR Washington. Talks and presentations were given by LCDR H. A. Wellemeyer, USN; CDR J. R. King, USNR, ONR Resident Representative, Stanford University; ENS H. Satow, USNR, Head, Inactive Section, Officer Personnel Branch, Twelfth Naval District; LCDR E. Kehoe, USNR; CDR Nello Pace, USNR, ONR Mobilization Liaison Officer, Twelfth Naval District; CDR P. M. Klein, USNR, Head of Patent Department, ONR, San Francisco; CDR H. C. Ries, USNR, Commanding Officer of NRRC 12-5. CDR Ries and LCDR Todd are with the Shell Development Company.

The Seattle meeting was also arranged by LCDR H. A. Wellemeyer. Fourteen officers were present: the commanding officers of six companies and eight staff members. In addition to the topics discussed by LCDR Wellemeyer, informative presentations were made by CDR E. C. Miller, USN, Research Program Officer, and LT E. S. Mitchell, USN, Mobilization Classification Officer, both from Headquarters, Thirteenth Naval District; CDR W. C. Avery, USN, Training Officer of the Research Reserve Program, ONR, Washington; LCDR W. D. Smith, USNR, NRRC 13-1, ONR Resident Representative, Seattle; CDR Julius Rockwell, Jr., USNR, NRRC 13-1; and CDR C. F. Bunje, USNR, member of Thirteenth Naval District Policy Board.

The one-day Boston conference was led by CDR John A. Sharpe, USN, Executive Officer and Assistant for Research Reserve, ONR, Boston. CAPT George K. Williams, USN, Commanding Officer, ONR, Boston, opened the conference with a welcoming address and participated in the conference. Other participants from the Boston office were Dr. Arnet L. Powell, Chief Scientist; CDR Arthur H. Healy, USNR, Contract Administration Officer; and Mr. Kenneth C. Bernstein, Administrative Officer. Presentations were also made by CDR H. V. R. Palmer, USNR, Special Programs Officer, Com ONE, and CDR J. K. Mitchell, USNR, ONR Mobilization Liaison Officer for the First Naval District.

U.S. GOVERNMENT PRINTING OFFICE : 1960 O - 549653

CAPT Aymond points to location of recently activated Research Reserve Company, NRRC 9-10, Evanston, Illinois. On his left (left to right) are CDR L. P. Hoskins, USNR; LCDR E. F. Kehoe, USNR; and CAPT Alban Weber, USNR, Commanding Officer of the new company.

IN THIS ISSUE

Direct Energy Conversion . . . . . Paul H. Egli 1
Direct energy conversion promises a solution to important military requirements for power sources—particularly for applications where silence, reliability, and freedom from maintenance are important.

Foaming the Runways 10
Does laying a blanket of foam on the runway prevent fire in a crash landing? Does it "grease" the skid? Navy tests have provided the answers to these and other questions.

Amputee Rehabilitation and Modern Artificial Limbs . . . . . CAPT T. J. Canty, MC, USN 16
A full rounded program, established early in WW II, is in operation at the Navy Amputee Rehabilitation Center—located at USNH, Oakland, Calif.

The IGY and Mean Sea Level . . . . Dr. June G. Patullo 21
The study of sea level has a long history, but it still presents many unanswered problems.

Oceanographic Expedition of the Survey Ship EXPLORER 30
Now transferred to the East Coast, the Survey Ship EXPLORER (OSS-28) takes scientists, oceanographers, and others on the most comprehensive oceanographic expedition undertaken by the USC & GS since the early 1880's.

Research Notes 32

On the Naval Research Reserve 33

NAVAL RESEARCH reports highlights of technical progress in research by Navy laboratories and contractors and the development of important naval research facilities. The magazine is listed for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Subscription price: $1.50 per year in U. S. and Canada; $2.00 per year, foreign; $0.15 per individual copy. Changes of address should be sent to Code 740, Office of Naval Research, Washington, D. C. Use of funds for printing this publication was approved by the Director of the Bureau of the Budget, February 12, 1958.

The Survey Ship EXPLORER (OSS-28). See the story beginning on page 30.